Forces and Motion

8-5 The student will demonstrate an understanding of the effects of forces on the motion of an object. (Physical Science)

8-5.5 Analyze the resulting effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction.
Taxonomy level: 3.1-B Apply Conceptual Knowledge

Previous/Future knowledge: Students have been introduced to the concept of unbalanced forces and rate and direction of motion in 5th grade (5-5.3). In 6th grade, students measured force in Newtons using a spring scale (6-5.6). Students have not been introduced to the concept of balanced and unbalanced forces in previous grades. The quantitative concepts that affect the magnitude and direction of moving objects will be further developed in high school Physical Science (PS-5.8).

It is essential for students to know that forces have a *magnitude* (strength) and a *direction*. Forces can be represented as arrows with the length of the arrow representing the magnitude of the force and the head of the arrow pointing in the direction of the force. Using such arrows, the resulting force (net force) and direction can be determined.

Forces acting on an object can be *balanced or unbalanced.*

Balanced forces will cause no change in the motion of an object.

- Balanced forces acting on an object in opposite directions and equal in strength, as shown in the arrows below, do not cause a change in the speed/magnitude or direction of a moving object.
- Objects that are not moving will not start moving if acted on by balanced forces.
  - For example, in arm wrestling where there is no winner, the force exerted by each person is equal, but they are pushing in opposite directions. The resulting force (net force) is zero.

5N 5N

  - Or, in a tug of war, if there is no movement in the rope, the two teams are exerting equal, but opposite forces that are balanced. Again, the resulting force (net force) is zero.

5N 5N

Unbalanced forces are not equal, and they always cause the motion of an object to change the speed and/or direction that it is moving.

- When two unbalanced forces are exerted in opposite directions, their combined force is equal to the difference between the two forces.
  - The magnitude and direction of the net force affects the resulting motion.
  - This combined force is exerted in the direction of the larger force. For example, if two students push on opposite sides of a box sitting on the floor, the student on the left pushes with less force (small arrow) on the box than the student on the right side of the box (long arrow). The resulting action (net force: smaller arrow to the right of the =) shows that the box will change its motion in the direction of the greater force as shown below:

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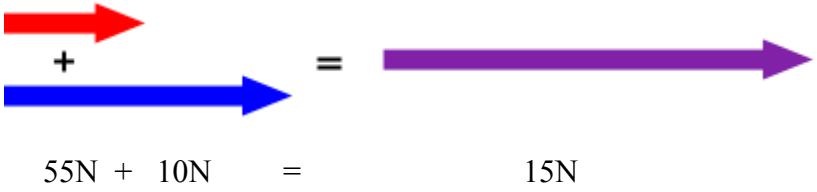
- Or, if in a tug of war, one team pulls harder than the other, the resulting action (net force) will be that the rope will change its motion in the direction of the force with the greater strength/magnitude as shown below:

- If unbalanced forces are exerted in the same direction, the resulting force (net force) will be the sum of the forces in the direction the forces are applied.
  - For example, if two people pull on an object at the same time in the same direction, the applied force on the object will be the result of their combined forces (net force or longer arrow to the right of the =) as shown below:



- When forces act in the same direction, their forces are added. When forces act in opposite directions, their forces are subtracted from each other.
- Unbalanced forces also cause a nonmoving object to change its motion

If there is no net force acting on the object, the motion does not change. If there is net force acting on an object, the speed of the object will change in the direction of the net force.

It is not essential for students to know how to determine net force when the forces act at an angle. Students do not need to calculate problems with more than two forces acting on an object.

Assessment Guidelines:
The objective of this indicator is to *analyze* the effects of balanced and unbalanced forces on the magnitude and direction of moving objects; therefore, the primary focus of assessment should be to determine from the factors presented how the balanced or unbalanced forces affect the magnitude and direction of moving objects. However, appropriate assessments should also require students to *recognize* whether forces acting on an object are balanced or unbalanced; *illustrate* forces as balanced or unbalanced depending on their magnitude and direction of moving objects; *infer* the resulting force of two balanced or unbalanced forces acting in opposite directions; *use* arrows to show balanced and unbalanced forces; or *use* the correct procedure (add or subtract) to calculate the net force.